Inquiry and Investigation
Lesson Plan

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Course Name: Physics

Core Curriculum Standard Fulfilled

Standard I: Students will understand how to measure, calculate, and describe the motion of an object in terms of position, velocity, and acceleration.

Core Curriculum Objective Fulfilled

Objective 1: Describe the motion of an object in terms of position, time, and velocity.

Intended Learning Outcomes (ILOs) Fulfilled

1. Use science process and thinking skills.
    a. Observe objects, events and patterns and record both qualitative and quantitative information.
    b. Plan and conduct experiments in which students may:
        - Predict results of investigations based upon prior data.
        - Identify variables and describe the relationships between them.
        - Collect data on the dependent variable(s).
        - Select the appropriate format (e.g., graph, chart, diagram) and use it to summarize the data obtained.
        - Analyze data, check it for accuracy and construct reasonable conclusions.
        - Prepare written and oral reports of investigations.

    i. Use mathematics as a precise method for showing relationships.
3. Demonstrate understanding of science concepts, principles, and systems.
    a. Know and explain science information specified for the subject being studied.
    c. Apply principles and concepts of science to explain various phenomena.
    d. Solve problems by applying science principles and procedures.

4. Communicate effectively using science language and reasoning.
    a. Provide relevant data to support their inferences and conclusions.
    b. Use precise scientific language in oral and written communications.
    e. Use mathematical language and reasoning to communicate information.

Time Needed To Complete Inquiry: Approximately 30- 45 minutes.

Inquiry: What is the research question to be scientifically investigated and how will your students actively participate? How will you use Guided Inquiry, Semi-guided Inquiry, or Open Inquiry as your teaching method?

What are the differences between displacement and distance; and how are those differences reflected in average velocity and average speed?

Students will answer this question by tying a battery powered car to a light string attached to a ring stand or taped to the floor so that the car must go in a circle. They will then be asked to determine the average speed and average velocity of the car at each of the four cardinal points on the circle i.e. at 0°, 90°,180°, 270°, and 360°.

The activity will be an open-inquiry. Students will already be expected to have some knowledge of average velocity and average speed. They will be given the task and shown the equipment set-up, but they will be expected to design their own methods of data collection and interpretation.

Assessment: How will you know that your students have met the objective? Are there application extensions to this activity, interpretative test items, etc.?

Students will create whiteboards to describe their methods, data, and conclusions. Test items could also be written asking students to determine average speed and average velocity for different cars or circles of different radius or at different positions on the circumference of the circle.

Prior Knowledge Needed: What background knowledge and skills do the students need to be prepared for this inquiry? How will they obtain it?

Students need to have already had some experience with average speed and average velocity with objects that travel in straight lines. They should also have some experience creating and interpreting graphs of position and time.

Introduction: Tell how you will introduce the inquiry to your students to make it meaningful and relevant.

I would most likely use this activity as a follow-up or lab-practicum at the end of a unit on constant speed motion, therefore I would introduce it as such. More creative minds will likely be able to invent a much better lead-in.

Materials / Resources Needed for the Investigation:

Constant speed battery powered car, string, strong tape or ring stand, stop watch, measuring stick or tape

Procedures of the Investigation: Describe the actual investigation. What will the students do? If applicable, identify the independent and dependent variables, the constants, and the repeated trials.

Students will allow the cars the travel in a circle around the tape or ring stand. They must make the mental connection of distance traveled with average speed and displacement with average velocity.

Distance traveled by the car for each of the four cardinal points mentioned above is simply the fraction of the complete circumference represented by the particular point. Average speed is simply the distance divided by the corresponding time.

Displacement is the straight-line distance (vector) from the starting point to the current position on the circumference. Students will need to measure this distance and divide it by the corresponding time to determine the average velocity.

This seems very straightforward when spelled out in this manner, but it strikes directly at the heart of the differences between these very different yet similar concepts. When students actually set out to accomplish the task given to them, there is a great deal of conversation and several false starts.

Data Collection: How will students collect and organize data (tabulation)?

Data can be collected in whatever manner students deem appropriate. This requires some monitoring by the teacher to prevent groups from getting too exotic or off-base in there methods, but teachers should avoid prescribing any specific methods, data, or procedures.

Students may naturally organize data into a table showing angles, distances, displacements, and times. However, students may also organize their data onto a circular chart, mirroring the car's path, which gives the relevant information.

Data Analysis: How will students be able to interpret the data (e.g., graphs), to reach consensus (if appropriate)? How will they draw conclusions?

Students will analyze and interpret data through diagrams of the car as it moves, group discussion, and class-wide whiteboard discussion. Many will likely come to correct interpretations and conclusions as they talk amongst themselves; however, a class-wide whiteboard discussion should be conducted to allow students to discuss their various methods and thought processes as they completed the task.

Closure: How will you provide closure to the experience? How will students effectively communicate what they learned?

The activity will end with a summary of the differences between average speed and average velocity. Students will also be assigned a written summary report of methods and conclusions.